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**REPORT OF
THE 1984
PACIFIC ALBACORE
GILLNET SURVEY**

by

David B. Holts
Earl C. Weber
Norman W. Bartoo

ADMINISTRATIVE REPORT LJ-85-11

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REPORT OF THE 1984 PACIFIC ALBACORE GILLNET SURVEY

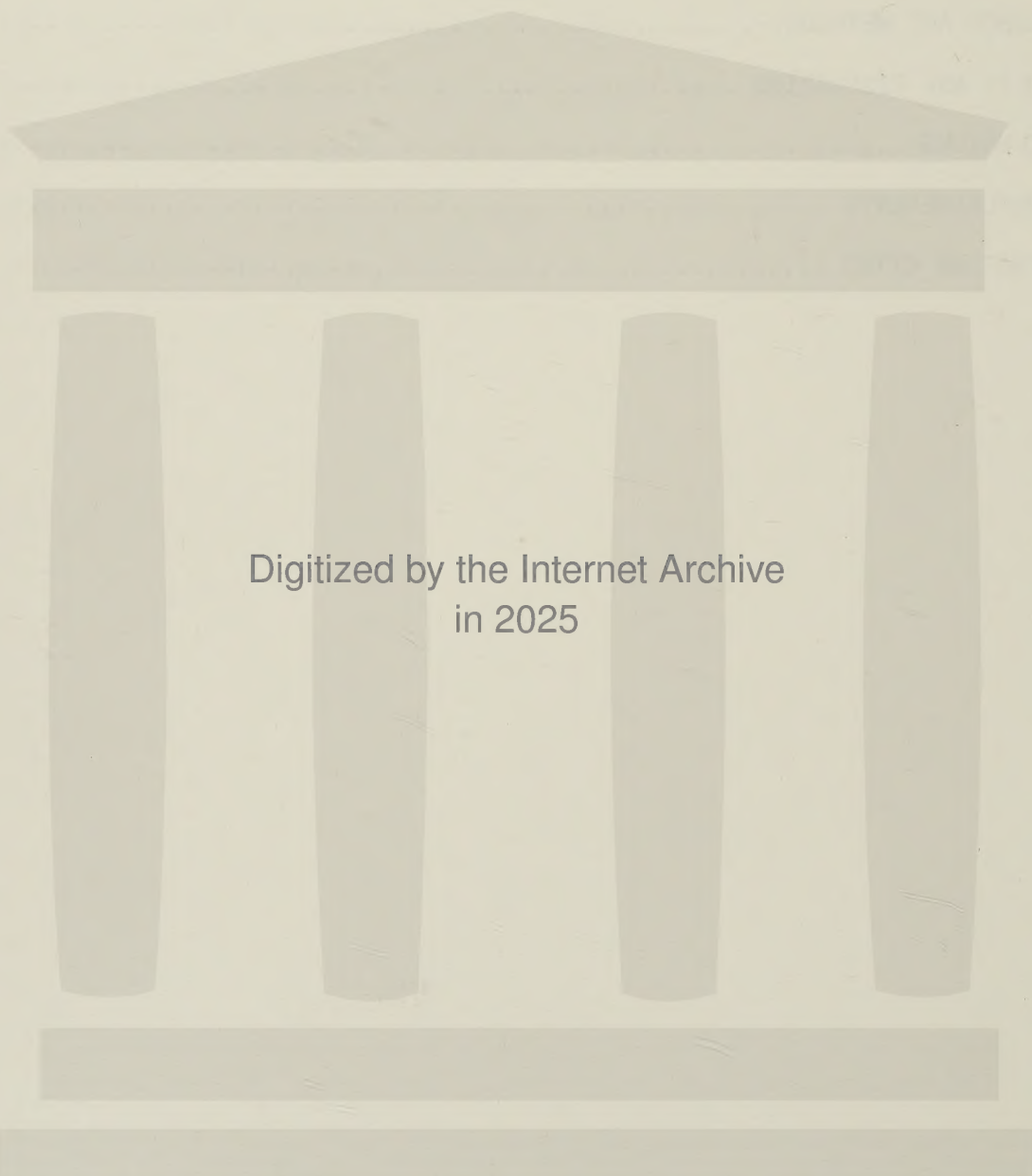
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INTRODUCTION

This research, which is part of the Southwest Fisheries Center's (SWFC) Albacore Research Program, was undertaken to define the dynamics of the North Pacific albacore (Thunnus alalunga) resource. Understanding the dynamics of this albacore population requires knowledge of the age or size structure of both the catch and of the population supporting that catch. The North Pacific albacore resource is harvested by several fisheries, and each fishery has a gear with a unique selectivity for fish size and specific zone of habitat fished. Commercial fishing gears are size selective in their catch (Baranov, 1948; Holt, 1963; Pope, et al., 1975 and Hamley, 1975), and consequently the current United States commercial troll and live bait fisheries are apparently unable to provide unbiased samples of the population from which they are taken.

To date, however, the only available measure of the size structure of the Pacific albacore population is that derived from the commercial catch. Because of the selectivity of the fishing gears, not all sizes of albacore are caught in proportion to their abundance in the population. For a better understanding of the dynamics of that underlying population supporting the fishery, a profile of the relative abundance of all sizes of fish in the population is needed. Also required is an estimate of the size selectivity of the commercial fishing gears.

After reviewing past experiments in which albacore were sampled with gillnets, we found that none of the experiments were designed to catch and quantify a cross section of available sizes of albacore. Nevertheless, these previous efforts (Powell et al., 1952; Graham and Mann, 1959) provided some guidance into mesh selectivity, vertical sampling, and day-night differences, which we used in the current experimental design. The analytical treatment for estimating the selectivity from fishery catch data has been worked out and reviewed (Hamely, 1975). Additionally, Bartoo (1977) used sample catches from carefully designed research nets to estimate the population size structure of three populations in Lake Washington, Washington.

APPROACH AND METHODS

The study area was dictated by the general location of the local U. S. albacore troll fishery and suitability of weather conditions. A review of logbook catch data for the previous 10 years indicated good August fishing south of Point Conception, California, and within about 500 miles of shore. We chose the exact sampling location after reviewing weather conditions and operational constraints (Figure 1).

The general procedures for this experiment included replicate sampling of the albacore population with specially designed gillnets. These nets consisted of several different mesh sizes from 4 to 10 inches in one inch intervals and were fished in various different depth strata from the surface to below the thermocline. In order to minimize assumptions needed to extend selectivity results to the commercial catch, we took all of our samples in reasonable proximity to the active U. S. commercial troll fishery. The number of repetitions of the experiment required to sample this population depend on the observed catch rates. An ideal sample of 100 fish per mesh size was needed to empirically estimate the net selectivity. However, as few as 10 fish in some of the mesh sizes and 30 to 50 in the others could provide enough information to estimate the net selectivity. Results from the Japanese commercial gillnet vessels, using multifilament gillnets, indicate catches of up to 10 fish per tan (33 m unit of net) per set were possible (Yonemori and Makiyara, pers com. 1983¹). At comparable catch rates, 14 sampling sets were required to estimate the age structure for the local albacore population.

Sampling vessels

The commercial gillnet vessel, F/V Steel Fin II, was chartered to set and haul the sampling gillnets. The F/V Steel Fin II is a 18.3 m (60 ft), steel hull fishing boat rigged with gillnet drum and net guard as well as standard commercial trolling gear (Figure 2). There is hold space for approximately 35 metric tons of fish, kept cold with a spray brine system. Two SWFC fishery biologists stayed on the vessel throughout the sampling period to direct and assist in the daily operations and collect required sampling data.

The F/V Steel Fin II was accompanied by the NOAA Ship David Starr Jordan throughout the sampling period to sample with jigs, scout alternative fishing areas, monitor environmental parameters, and carry out a number of related research projects. The Jordan is 52.5 meters long (172 ft) and was outfitted with commercial trolling gear for this cruise.

Description of sampling gear

The two sampling gillnets constructed for this project were built as sinking nets, suspended at desired depths by dropper lines attached to surface floats. Each sampling net consisted of fourteen (14) 33 m panels of webbing. Each had two complete sets of seven different mesh sizes. The mesh sizes were 95, 121, 146, 171, 184, 197, 222, and 248 mm stretched mesh (corresponding to 4, 5, 6, 7, 7.4, 8, 9, and 10 inches, before shrinkage). The number of meshes deep for these panels varied in number so that all panels fished a consistent depth of 12 m. These two sampling nets were connected to the chartered vessel's commercial albacore gillnet (Figure 3). The commercial net was 1000 fathoms (1830 m) long and the stretched length of the mesh was 148 mm (7.38 in).

¹Tamotsu Yonemori (Far Seas Fisheries Research Lab) and Mokoto Makiyara (Japan Marine Fishery Resource Center), May, 1982.

The albacore population was also sampled with various forms of commercial trolling gear by both vessels to attract fish in all possible size ranges. These activities were also aimed at locating favorable areas for setting the sampling nets. These methods are well known and have been described by Dotson, 1982.

Experimental and operational design

All nets, research and commercial portions totaling 2800 m, were deployed daily at scheduled set times. Night sets began at approximately sunset and were hauled in the pre-dawn hours of the following morning. Day sets started before noon and retrieval began in the afternoon.

As fish were removed from the net during retrieval, they were tagged with information listing the mesh size, panel number where caught, whether gilled, wedged, or tangled, plus any other pertinent information. This tagging permitted us to postpone required measurements and sampling until after the net had been safely retrieved. Fork-length, girth at the gills and maximum body girth were then taken for all albacore and skipjack unless damaged by the net, sharks, or sea lions. Damaged fish were simply counted as were sharks, swordfish, mackerel and other incidental species.

At the same time the sampling net was being deployed, the Jordan made a series of four conductivity, temperature and depth (CTD) casts in a rectangular pattern surrounding the net. Data from these casts were stored on cassette tapes by the ship's on-board computer system. Expendable bathythermograph (XBT) casts were taken as needed to provide real time temperature-depth profile information.

Trolling operations began as soon as the gillnet and deck gear were secured. The jig lines were put out with artificial lures and a watch was begun to monitor all jig strikes. When an albacore strike occurred, the vessel was put into a slow turn to catch as many fish as possible in that area. Circling these areas of fish continued for 5 to 30 minutes depending on the amount of catch. When good areas of fish were located, the gillnets were set and fished in that area during the evening.

Data on location and time that albacore and skipjack were caught were recorded as were specimen size and condition, gear type, and specific weather and oceanographic conditions.

RESULTS AND DISCUSSION

Catch and effort

A total of 12 night and two daytime albacore sampling sets were made at head rope depths ranging from one to 20 meters (Table 1). The length of time required to set the net was normally just less than one hour, and approximately three to six hours were needed for retrieval depending on the number and species of fish caught and sea conditions. The mean soak time (the time from finished setting to finished hauling) for day sets was 4.4 hours and for night sets, 11.3 hours.

The gillnet catch included 454 albacore, 276 skipjack tuna, two bigeye tuna and several incidental species (Table 2). Trolling operations on the F/V Steel Fin II produced 513 albacore and 155 skipjack while the Jordan caught 250 albacore and 63 skipjack. Trolling aboard the Jordan only occurred while scouting for new or alternate fishing areas or when examining specific areas to set the sampling nets. These catches, catch locations and environmental conditions were used to locate the most advantageous set locations. Trolling effort by the Jordan was discontinuous and conducted at various speeds depending on other research activities and Jordan effort data are not comparable between the vessels or to other commercial vessels.

The trolling effort aboard the F/V Steel Fin II varied from normal commercial troll effort only in that the starting time was after the gillnets were hauled and secured instead of at first light (Table 3). The catch averaged 32.1 albacore and 9.9 skipjack per day and a total of 42.0 fish per day (0.39 fish per line-hour). These numbers are somewhat lower than the 1983 and 1984 commercial catch average for this general area and are indicative of the generally poor fishing experienced during this time.

Size composition

Following the cruise, the collected data were edited and entered onto a data base for summarization and statistical analysis. Generated from this data base were individual and cumulative length frequencies by species, area caught, gear type and, in the case of net caught fish, mesh size. The cumulative length frequencies were analyzed by plotting on probit paper and used to develop gear selectivity curves. The size of the catch by trolling and by gillnet is shown in Figure 4 for albacore and Figure 5 for skipjack. Although the gillnet captured a slightly greater range of albacore it is clear that both gear types sampled a similar length range.

The mean girths for each length class were plotted for both the girth at the edge of the gill covers and the maximum body girth for both albacore (Figure 6) and skipjack (Figure 7). Both maximum girth and the girth at the gills vary linearly with fish length.

Mesh size and selectivity

A complete net selectivity analysis was not possible because few or no albacore were caught in some mesh sizes (Table 4). Where possible, however, selectivity curves (Pope, et al., 1975) were fitted to the data.

In this procedure we generated a cumulative length-frequency for the albacore caught in each mesh size, determined the cumulative proportion caught at each length, calculated the normal deviates (Z values) of these proportions which produced linear values and, finally, plotted the normal deviates against the fish lengths. Selectivity curves for mesh sizes 146, 171 and 184 mm are shown in Figure 8. The slopes of the lines are approximately the same, indicating homoscedasticity in the relationship between size of albacore caught in the different mesh sizes. The peak sizes caught by each mesh size (the point where $Z = 0$) are 64.0 cm for mesh size 146 mm, 65.8 cm for mesh size 171 mm, and 64.4 for mesh size 184 mm (the

commercial portion of the gillnet). These modal sizes are similar due to the predominance of albacore in a single modal length interval. Note that the peak sizes do not increase correspondingly with mesh size. Instead, the peak size for the commercial net, the largest mesh of the three, fell between the peak sizes of the two experimental mesh sizes. This is thought to be due to greater slack in the commercial webbing and a concomitant bias toward smaller fish (von Brandt, 1975).

Distribution of catch within the net

Recent reports of sonic tagging and tracking results indicate that the depth of the albacore habitat may extend into and possibly below the thermocline (Laur, et al., 1982). The portion of the experiment designed to test the effects of depth was modified from four sampling depths to two because of the low catch rates. Sample size does not permit valid statistical comparisons, although some interesting observations are possible. The depth of the catch in the commercial net was noted in 9 of the 12 night sets. In 8 of these sets, the catch was at or above the sharpest temperature break in the thermocline (Fig. 9). In set 12, the catch was well below the thermocline. Eight large albacore were caught in this set located 25 nautical miles south of San Nicolas Island. The mean length of albacore was 80.1 cm, whereas the mean length of albacore for the entire trip was 65 cm, suggesting that, at the time of sampling, the fish from this area were moderately different in size composition than those sampled elsewhere.

Horizontal catch distribution within the net also varied in several ways. General observations indicated that the catch tended to be clumped or grouped. Often fish would be hauled aboard in groups of three or more with long sections of empty net between. In one set (set 9) a large group of albacore were hauled aboard that had just been caught and were still alive. These fish were all grouped in a small section in the lower half of the commercial net indicating the group had just recently encountered the net.

Incidental catch by gillnet

In addition to albacore and skipjack tuna, there were 11 other species of fish taken by gillnet (Table 5; also see Table 2). In two sets (3 & 10) the incidental shark catch created problems. Good albacore catches attracted blue sharks that became gilled while they tried to eat fish already gilled in the net. Removing the sharks caused a delay in retrieving the net, which allowed time for more sharks to become entangled in the gear remaining in the water. There is no way to estimate fish loss due to sharks, but net damage was heavy on these sets. California sea lions (Zalophus californianus) were observed around the net during two sets. Several fish, which had been badly mauled by the sea lions, were recovered from the net. However, no sea lions or other marine mammals were tangled in the nets.

CONCLUSIONS

This study shows that gillnets are a useful sampling tool for albacore and that it is possible to quantify the effects of gear selectivity with adequate sampling results. With an increase in sampling stations, an adequate sample size can be obtained that would allow for a rigorous statistical analysis. This in turn can provide unbiased estimates of the size structure of the local albacore population.

ACKNOWLEDGEMENTS

We wish to thank Mr. Tony West, owner of the F/V Steel Fin II, and Mr. Mitchel Collins for their generous cooperation and assistance throughout this research. Captain Manual Ferreira and the entire crew of the NOAA Ship David Starr Jordan provided much needed support and assistance. Our thanks also go to the following scientific staff aboard the Jordan: John Hedgepeth, Hannah Bernard, Bob Pitman, Tom Tumosa, John Michno and Tony Sarain from the NMFS and to Alberto Garces from the Spanish Institute of Oceanography, Madrid, Spain.

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Table 1. Summary of set locations and conditions.

DATE AUG.	SET NO.	SET TIME	LOCATION Lat. °N	Long. °W	FLOATLINE DEPTH (m)	SOAK TIME (hours)	SST °C	BEAUFORT NO.	THERMOCLINE DEPTH (m)	DEPTH OF CATCH
9	1	2005	31 53	118 22	15	10.5	20.6	0	21	-
10	2	2100	31 55	118 40	1	10.5	20.6	0	25	-
11	3	1930	32 00	118 56	20	12.5	20.6	1	22	upper center
12	4	2200	33 00	120 22	15	10.7	18.5	3	33	upper third
15	5	1930	31 58	118 55	30	11.5	21.5	1	24	scattered
16	6	1030	31 58	118 55	15	3.5	21.5	1	24	none
16	7	2010	31 57	118 53	15	11.3	21.5	2	22	upper middle
17	8	2020	31 57	118 58	15	11.5	21.5	2	22	upper half
18	9	2255	33 00	120 26	15	9.1	19.9	3	34	lower half
19	10	2200	33 35	120 45	5	13.1	20.5	4	20	top third
21	11	2015	33 35	121 00	5	12.2	20.8	3	13	top third
23	12	2245	33 04	119 20	5	11.7	20.8	2	13	lower half
24	13	2230	33 06	119 02	5	11.5	22.7	2	18	-
25	14	1030	33 06	119 02	1	5.3	22.7	2	18	none

Table 2. Catch of major species in sampling nets, by set

Set No.	ALBACORE	SKIPJACK	BIGEYE	SWORDFISH	SHARKS			
					Thresher	Bonito	Hammerhead	Blue
1	84	11	0	0	0	0	5	5
2	45	27	0	1	0	0	0	3
3	82	0	0	0	0	0	0	170
4	9	0	0	3	0	0	1	4
5	65	95	0	0	0	1	0	0
6	0	0	0	0	0	0	0	2
7	36	33	0	1	0	3	2	4
8	26	53	0	0	0	0	2	4
9	32	0	0	0	0	2	0	0
10	54	0	0	1	0	12	0	120
11	35	0	1	0	1	15	0	6
12	8	0	0	0	0	1	0	0
13	2	13	1	0	0	0	0	0
14	0	5	0	0	0	0	0	4
Totals	478	237	2	6	1	34	10	332

Table 3. Catch of albacore and skipjack during trolling operations of the F/V STEEL FIN II.

DATE	LINES TROLLED	HOURS TROLLED	CATCH		CATCH ALB	PER LINE SK	LINE HOUR TOTAL
9	11	12	84	11	0.64	0.08	0.72
10	11	12	45	27	0.34	0.20	0.55
11	11	10.5	82	3	0.71	0.03	0.72
12	11	9	9	0	0.09		0.09
13	10	9.5	10	0	0.11		0.11
14	10	13.5	7	0	0.05		0.05
15	10	10.5	41	48	0.39	0.42	0.77
16	10	5.5	13	16	0.24	0.29	0.53
17	10	12.5	45	17	0.36	0.14	0.50
18	10	12	32	20	0.27	0.17	0.43
19	10	10	35	0	0.35		0.35
20	10	9.5	45	0	0.47		0.47
21	10	9.5	35	0	0.37		0.37
22	10	10.5	15	0	0.14		0.14
23	10	11	15	5	0.14	0.04	0.18
24	10	9.5	0	15		0.16	0.16
Total		169.5	513	158			
Average		10.6	32.1	9.9	0.30	0.09	0.40

Table 4. Total number of albacore and skipjack caught in each size mesh.

MESH SIZE (mm)	95	121	146	171	184	197	222	248
ALBACORE	5	4	8	12	347	3	0	2
SKIPJACK	0	5	1	2	108	0	0	0
TOTALS	5	9	9	14	455	3	0	2

Table 5. Catch of incidental fish taken in the gillnet.

Bigeye Tuna	<u>Thunnus obesus</u>	2
Bullet mackerel	<u>Auxis rochei</u>	13
Pacific mackerel	<u>Scomber japonicus</u>	12
Jack mackerel	<u>Trachurus symmetricus</u>	8
Swordfish	<u>Xiphias gladius</u>	5
Blue shark	<u>Prionace glauca</u>	332
Bigeye thresher	<u>Alopias superciliosus</u>	1
Bonito shark	<u>Isurus oxyrinchus</u>	34
Scalloped hammerhead	<u>Sphyrna lewini</u>	5
Pacific pomfret	<u>Brama japonica</u>	5
Louvar	<u>Luverus imperialis</u>	3

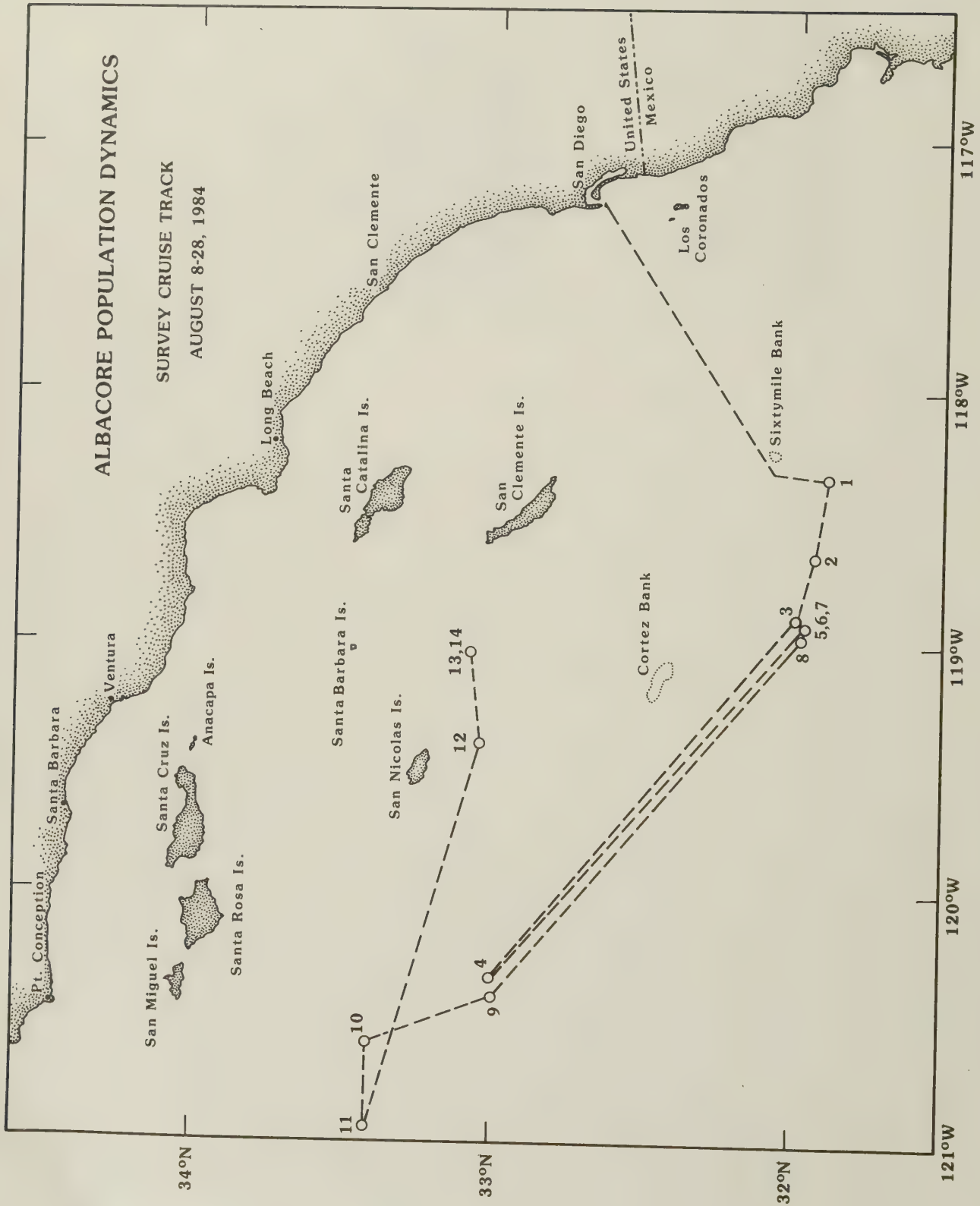


Figure 1. Albatross population dynamics survey cruise track, August 8-28, 1984.



Figure 2. The F/V Steel Fin II during fishing operations.

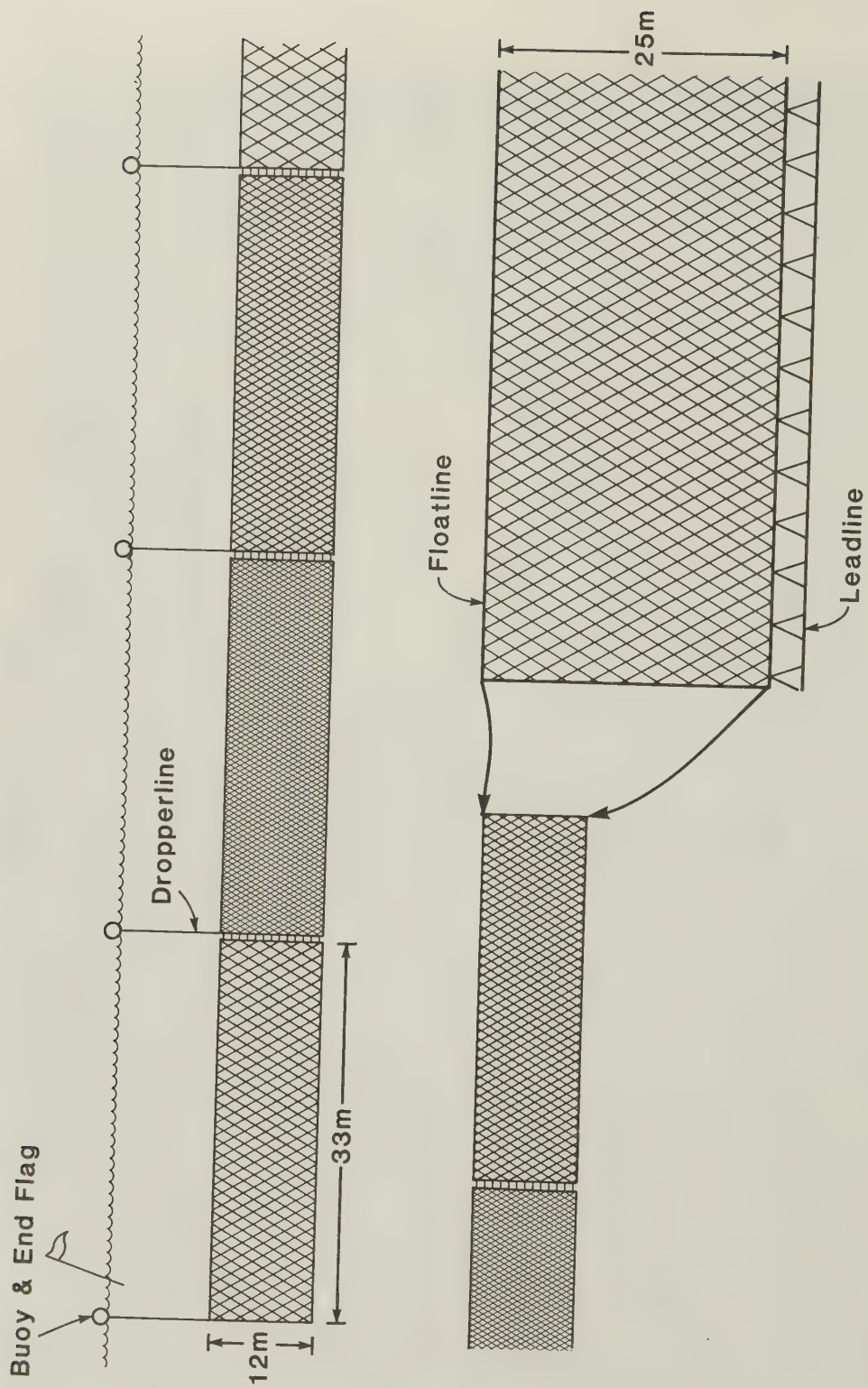


Figure 3. Configuration of NMFS and commercial sampling gillnets.

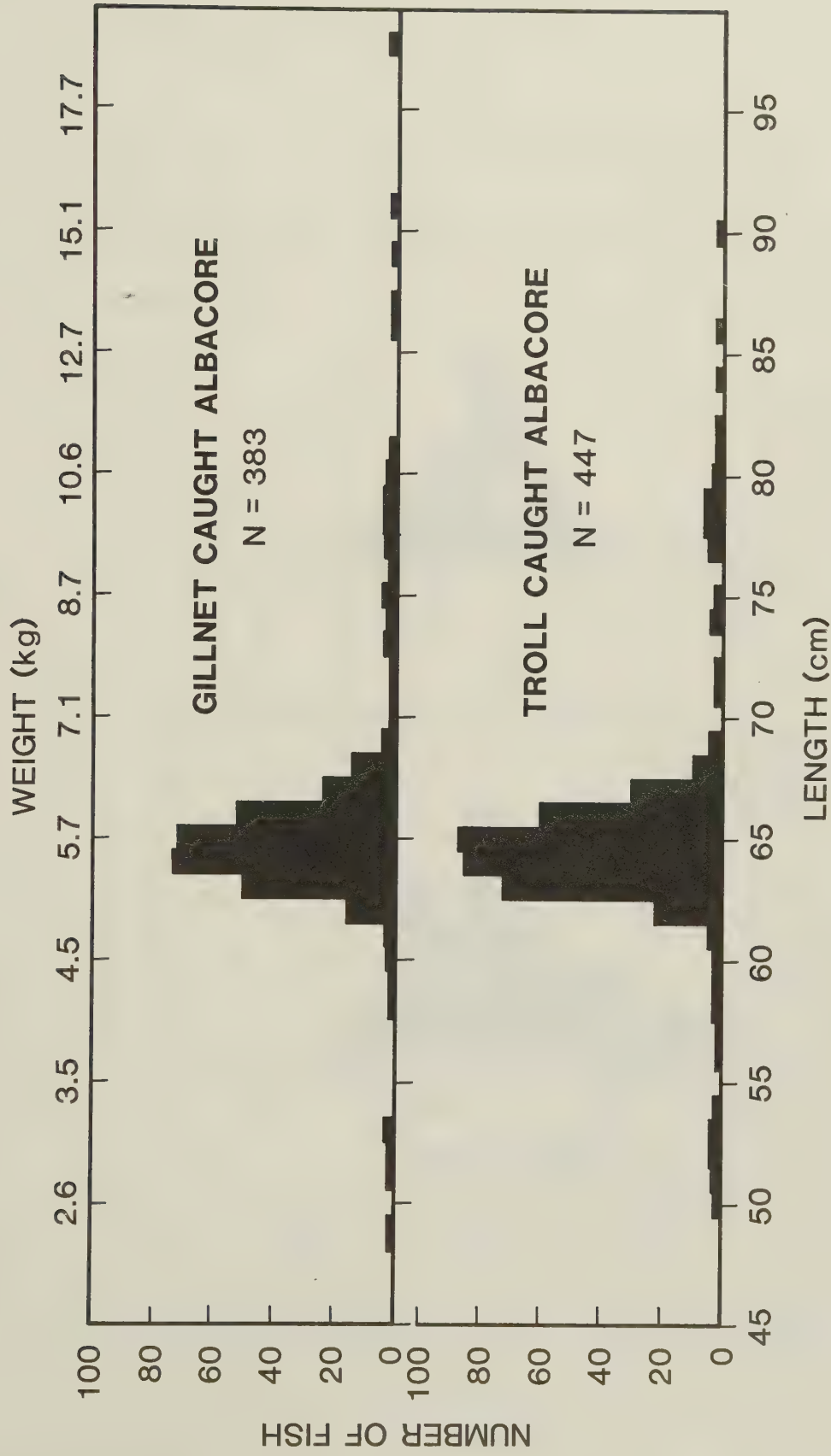


Figure 4. Length frequency of albacore caught by gillnet and trolling gear.

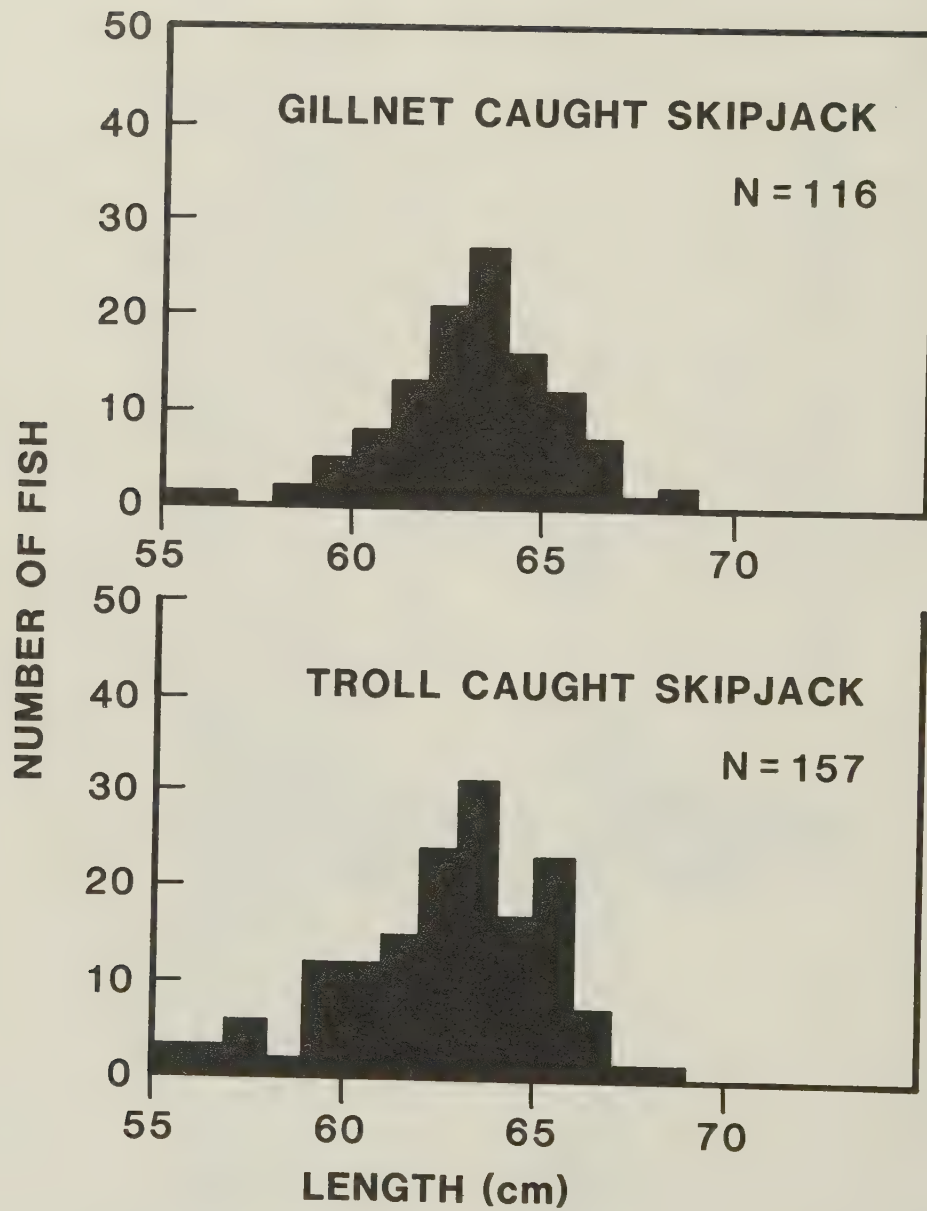


Figure 5. Length frequency of skipjack caught by gillnet and trolling gear.

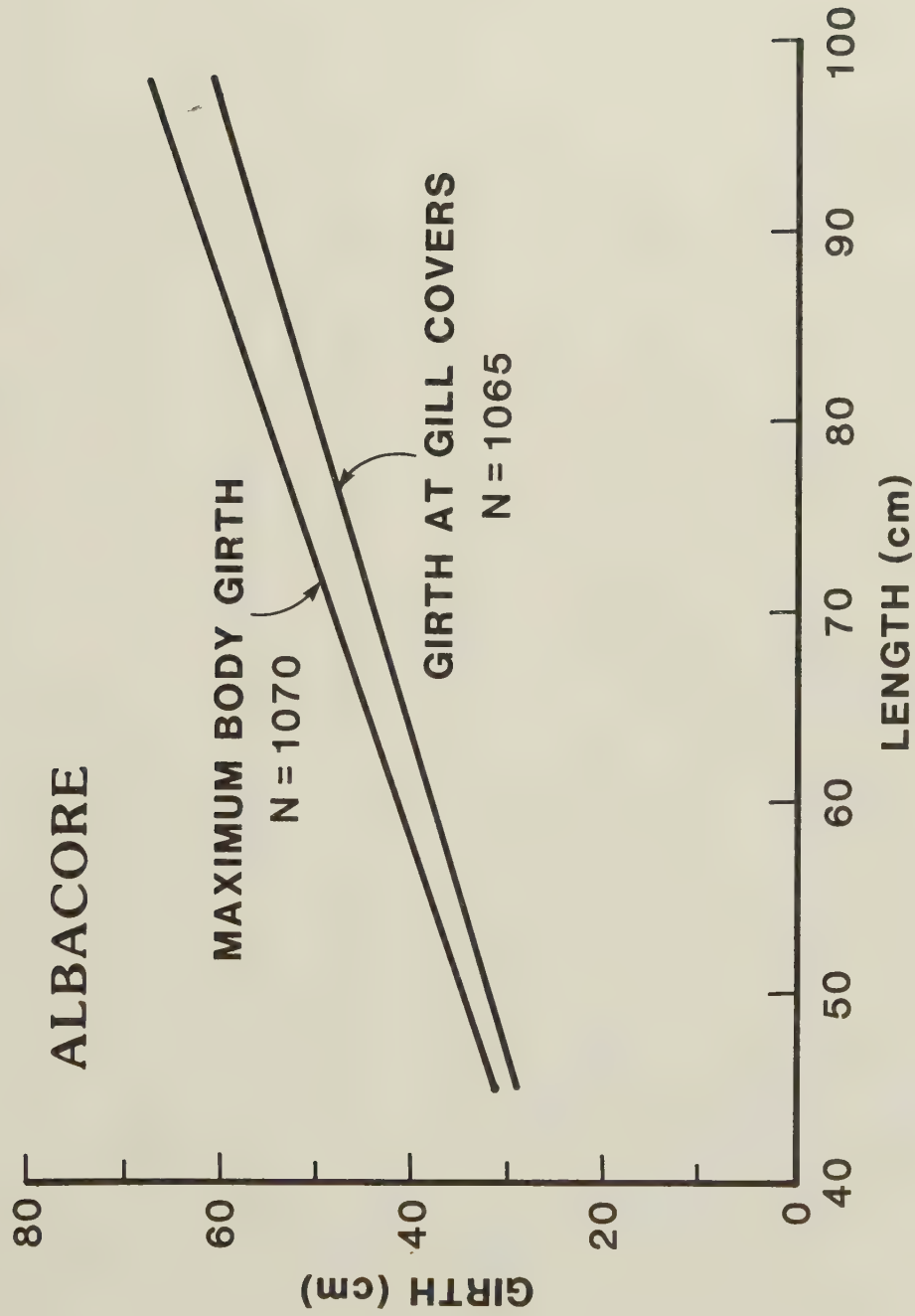


Figure 6. Mean girths at edge of gill covers and at maximum body extension for albacore.

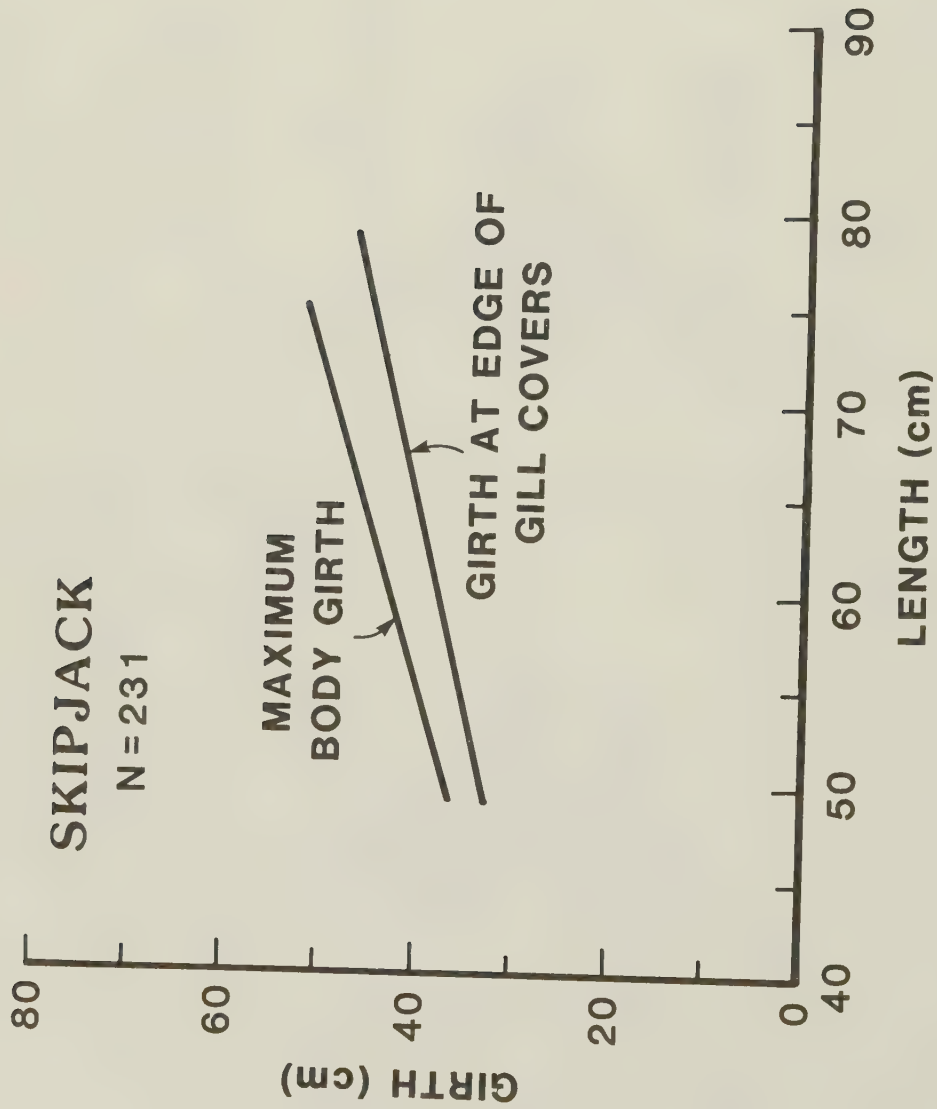


Figure 7. Mean girths at edge of gill covers and at maximum body extension for skipjack.

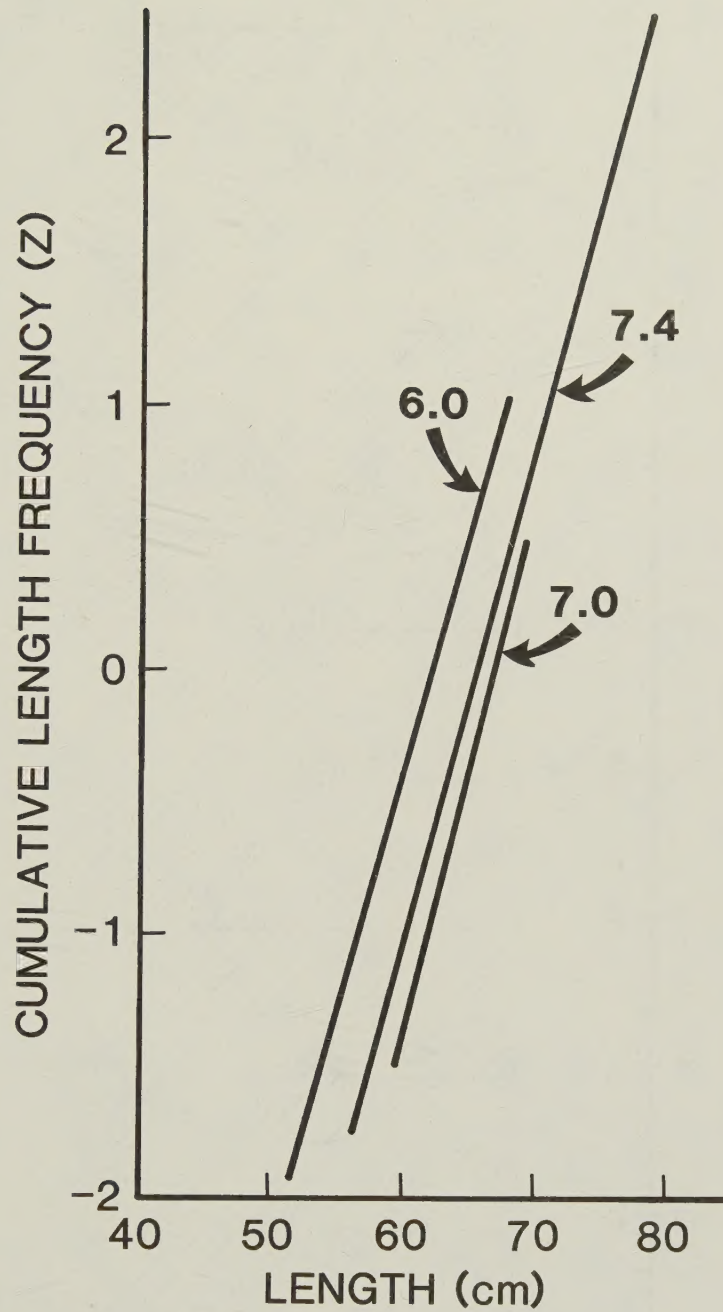


Figure 8. Cumulative length frequencies for three sizes of mesh.

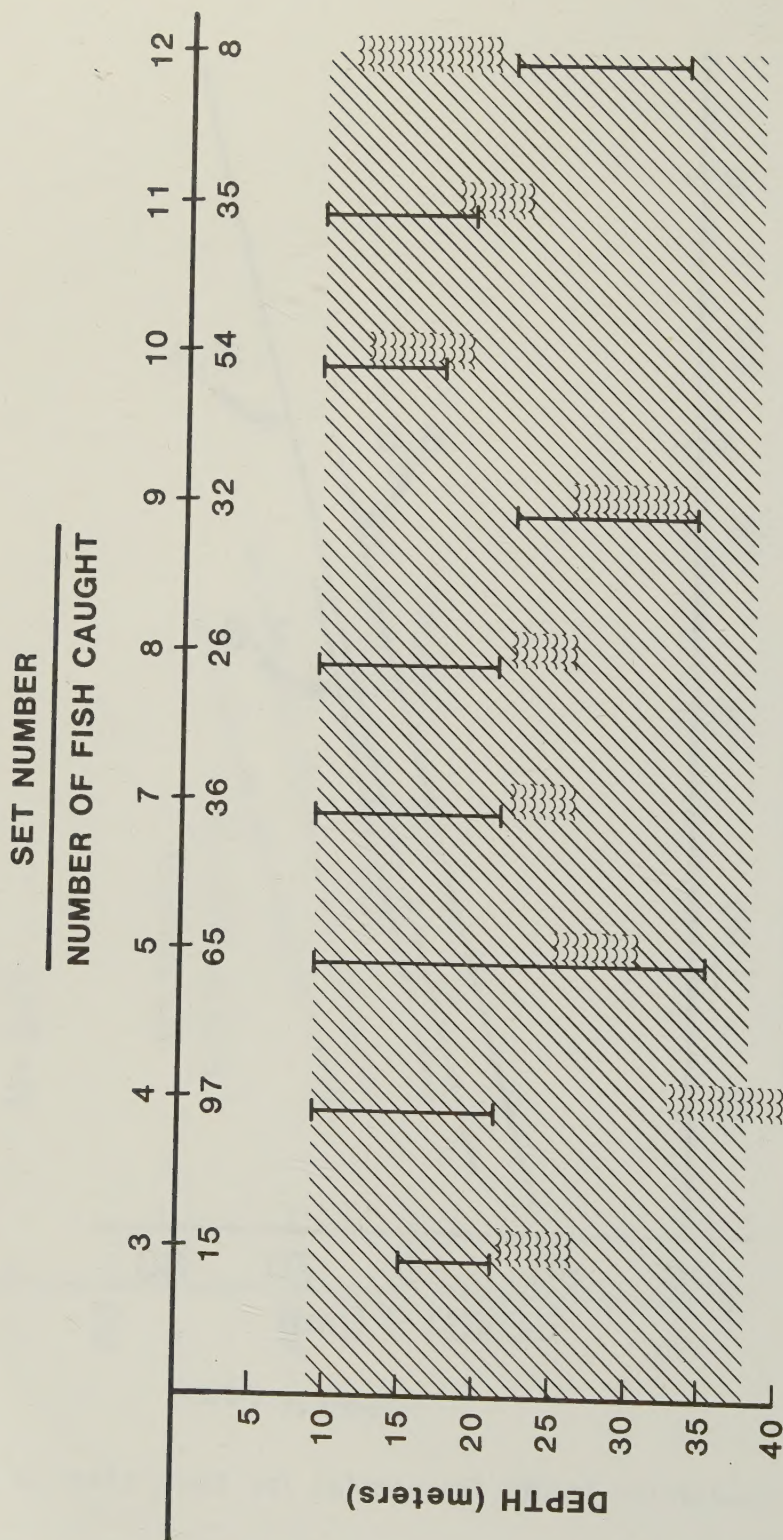


Figure 9. Depth of catch in relation to thermocline (wavelets) and the commercial gillnet (shaded) for nine sets.

